

was not more than their Prime Cost; the dearness of keeping them near *London* necessitating the Cow keepers to buy the very best.

His Majesty was further pleased, on the Solicitation of the four Gentlemen, to grant a Brief for the 24500*l.* but the many false Reports that were then industriously propagated, to lessen the value of those poor Mens losses, so frustrated that Charity, that the entire Sum Collected (the charges of Collecting being first paid) was but 6278*l.* 2*s.* 6*d.* which on a Dividend, amounted to *Five Shillings and Three Half Pence* in the Pound, computing their Loss as above, at *Six Pounds per Cow*; tho' if we consider their Contracts with Brewers for Grains, their Rent of Grounds which lay useless, Servants wages, &c. their real Loss may (by a modest Computation) be allowed to be *Ten Pounds* for every Cow that died.

IV. *A Description of the Organ of Hearing in the Elephant, with the Figures and Situation of the Offices, Labyrinth and Cochlea in the Ear of that large Animal. Communicated to the Royal Society, by Dr. Patrick Blair, R. S. S.*

IN the Description I formerly wrote to the Honour'd Sir *Hans Sloane*, Bart. of the *Elephant* I Dissected in *Lundee*, *April* 1706. which he was pleased to Communicate to the *Royal Society*, as you have it in *Philos. Transf.* N^o. 226 227. I treated of the Bony part of the Ear of that prodigious Animal a little too superficially: because I was unwilling at that time to break up the *Os Petrosum* of the right Ear, which had accidentally
been

been separated on dividing of the Skull, by which the account I then gave of the *Linea Semilunares*, or *Labyrinth* and *Cochlea* was but *Lame*. But I have chosen since rather to destroy that Bone (however seldom such Bones are to be met with) than that the Publick should be depriv'd of an exact Description of that curious Organe, and that I may give a clear Idea of all its Bony parts, I shall repeat what I formerly advanc'd upon that Subject, and add what Improvements I have made upon it since.

Before I proceed, 'tis fit I observe that the *Auris Externus* of this big Creature lyes flat, and not Protuberant as in other Quadrupeds, whose Cartilaginous Substance is capable of divers Motions perform'd by several Muscles, whereby the inner Ear is preserv'd from the great violence of the External Air, which upon some occasions might perhaps injure or break the thin and delicate Membrane of the *Tympanum*. It is also for this reason that the *Meatus* is further guarded, by the Contorsions and oblique Position of the Cartilage at the Orifice of the *Meatus*, which only admits of a determinate quantity of Air, sufficient for the vibration of the *Membrana Tympani*, by which a distinct sound is convey'd to the *Sensorium commune*; whereas did the Air admitted exceed its due proportion, nothing but the confus'd Idea of a Sound would follow, such as resemble the rushing of Waters, &c. or that noise often observ'd when, by a supervenient Cold or the like, obstructions are generated within the Ear it self. And in Man, because the *Auris externus* is also flat, not only are these turnings and windings observable in the Cartilage at the entry, but the *Meatus* it self is likewise obliquely Situated, to prevent the aforesaid inconveniencies. But there is no need for such a contrivance in the *Elephant*, whose external Orifice of
the

the *Meatus* is patent, open (scarfe being guarded by the Cartilage) and streight, whose length (it reaching from the external to the internal Table of the Scull) is sufficient to prevent the accession of too great a quantity of Air to the *Tympanum*; for in its progress most of the *Columna Aeris* beat against one or other of the sides of the *Meatus*, in so much that their force is inhibited, and only so many as suffice to convey the Sound, can reach the *Tympanum* it self.

The *Meatus Auditorius* then is a long streight Tube or *Canule* situated Horizontal-ly, and reaching from the outer to the inner Table of the Scull, in Figure not unlike the Barrel of a Pistol, but somewhat Oval, the sides of whose Cavity are hard and solid, about the thickness of a Half-penny, from whose outer Part several of the *Lamina* betwixt the two Tables of the Scull do arise, (Fig. I.) Its Cavity is an Inch or $\frac{3}{4}$ of an Inch Diameter, and length $9\frac{1}{2}$ Inches; being somewhat enlarg'd as it arrives at the *Crena* for the *Membrana Tympani*. (Fig. II.)

Meatus Auditorius.

This *Crena* is two Inches in Circumference, within which is the *Cavitas Tympani*, consisting of two different Surfaces; the one much deeper and Cellulous, the other more superficial and Smooth. The first runs perpendicularly down $\frac{1}{2}$ Inch from the *Crena Tympani*. Its bottom is variously divided into several *Celluls*, not unlike a Honey Comb, but irregularly dispos'd. Its Bony *Lamina*, by which these *Cellules* are distinguish'd from each other, are thicker at the Top than at the Bottom, they being one Line, two Lines, or $1\frac{1}{2}$ Line distant from each other, and about $\frac{1}{4}$ Inch deep. Could I have got it so well cleans'd as I wish'd for, doubtless I might have observ'd their Communication with each other, by means of certain Orifices which serve to convey what super-

Crena and Cavitas Tympani.

Y y y y y

fluus

fiuous Moisture is contain'd in them for we may reasonably suppose, as in all other Cavities of the Body, there are certain Glands for separating proper Liquors convenient for the uses design'd; so here there seems to be a necessity for separating a certain quantity of Moisture, fit to lubricate the Muscles of the Ossicles, and facilitate their Motion; as also to preserve the *Membrana Tympani* from becoming too dry. This dryness of the *Membrana Tympani*, and the thickness of the Liquor separated by these Glands, is often the cause of a Deafness in Human Subjects; especially those that are advanc'd in Age. This cellulous Structure of the *Cavitas Tympani*, seems to be very proper for receiving of the superfluous Humidity; and these Communications are requisite for conveying it from one Cellule to another, till it is emptied into the *Receptaculum Commune* the *Aqueduct*, whereof hereafter.

This first or cellulous Cavity is two Inches broad, and reaches from the *Crena Tympani* to the *foramen Ovale*, or entry into the *Vestibulum*, which is shut by the *Stapes*. The second Part of this Cavity is more superficial (*Fig. II. (e)*), in form not unlike a Pear, from a narrow beginning becoming broader and more superficial, terminating Semicircularly, smooth in the Bottom, and having several incurvated Lines running across it; it reaches much farther than the *Vestibulum*, being one Inch five Lines from before to behind, and one Inch transversely where broadest. What superfluous Moisture it contains is discharg'd into the fore-named *Aqueduct*.

Beside the above-mentioned uses for these two Cavities, *viz.* to receive and discharge the superfluous Moisture; they are also most beneficial and assisting to the Hearing: for, no sooner is the external Air modulated, and the *Membrana Tympani* mov'd thereby,
than

than the Sound is conveyed by the *Ossicles* to the *Nervus Auditorius*, and the Undulation continued, first by the *Anfractuosities* of the first Cavity, and then by the *Gyres* and incurvated Lines of the second, so that we may easily account for the acute Sensation of Hearing, wherewith *Elephants* are said to be endow'd: For as the Tame ones are most exact in obeying their Masters commands; so the wild Ones are soon aware of what Traps or Snares are laid to catch them, by the tremulous Motion convey'd to their Ear from the Cavour parts of the Earth, where the Pit into which it is expected they should fall, is digg'd. It is easy therefore to explain whence the acuteness of the Sensation of this Animal may proceed; for as the *Nervus Olfactorius* has a large Space and Bounds wherein to be dispers'd, *viz.* the two Cavities of the *Proboscis*, which are both long and large, so that scarce any *Columna aeris* can enter them, but some one or another of the Filaments of the *Nervus Olfactorius* dispers'd in these Cavities must be toucht, whereby the Idea of smelling must be conveyed to the *Sensorium commune* in a more intense Degree, and the Animal soon become sensible of whatever approaches that is noxious or nauseous to it, and thereby is taught how to avoid it; so this Structure, for a quick conveyance and long continuance of the Sound, is a great means both to make the *Elephant* soon receive the Sound and have a deep impression of it.

The *Aqueduc̄* is a flat Tube or Pipe, whose Orifice is so situated betwixt the two fore-mentioned Cavities, that if there be any superfluous Humidity contain'd in them, it must needs be discharg'd (at least in this Animal) into the Mouth; for as it is situated where the first Cavity terminates, so the second, from a broader and more superficial be-
The Aqueduc̄.
 Y y y y y 2 ginning.

ginning must needs discharge its Moisture, by its more narrow and deeper termination, into this receptacle; also it descends directly towards the Mouth, passing through the Scull below the hole for the Jugular Vein (*mm*) betwixt the hole for the Carotid Artery, (*pp*) and that for the *Arteria dura matris* (*qq*) whence descending (*nn*) it is join'd with its

Osteographia Elephantina, or Philos. Transact. No. 327. Tab. 3. Fig. 3.

Fleshy part, which discharges it self into the Mouth on each side, behind the back part of the inner Teeth of the upper Jaw. This situation of the Aqueduct makes it plainly appear, that its Use is to receive the superfluous Moisture from the *Cavitas Tympani*; for beside the Glands above-mentioned, fit for separating such a quantity of Humidity as may lubricate the Muscles and facilitate both their Motion and that of the *Officles*; the very Vapours that arise in such a Cavity as that of the *Tympanum* in this Animal, must at last be converted into a Liquor, and that must either again be receiv'd into the Blood Vessels, or otherwise discharg'd by such a Receptacle as this. Further if there be a necessity for Glands in the *Meatus Auditorius* without the *Tympanum*, to separate a certain Liquor, by which the acrimonious Particles of the Air are obtunded, and hindred from being offensive to the Nervous Membrane of the *Tympanum*, (which must be of a most acute Sensation) and for moistning it, by which it the more easily receives the Vibration of the Air; so such Glands as these seem to be most requisite in the *Cavitas Tympani* for the Uses above nam'd. And since what superabounds of this Moisture, cannot be discharg'd outwardly as that of the *Meatus*, this Aqueduct seems to be most convenient for that purpose. Some are of opinion that this Aqueduct is also assisting to the Hearing, especially in Men; because it is generally observ'd that

that they who are Deaf, open their Mouths wide, when they are desirous to hear more distinctly: But I see not how that can be, for tho' the Cavity of the Bony part of the Aqueduct, in most of Animals, is proportionally large enough; yet its carnous or fleshy Part lyes for the most part so flat, and its two sides are so collaps'd together, that scarce any Air can be admitted, at least so far as to be subservient to the Hearing.

The *Officles* in this as in other Animals are three or rather four in number; for though I did not procure the *Os quadrangulare* of *Du Verney*, yet I have good reason to believe it was there; because there is a conspicuous *Sinus* in the extremity both of the *Incus* and *Stapes*, where they are articulated, so big as to contain the Head of an ordinary Pin; and when I consider the Angle which must have been form'd by the articulation of these two Bones, I look upon this small Bone to serve for the same purposes as the *Patella* in the Knee, and *Sesamoide* Bones in the Fingers and Toes.

*The four Bones
of the Ear.*

The *Malleolus* is an irregular Bone, and doubtless has been endow'd with pretty large Muscles, because of the rugosities, protuberances and *Sinus's* observable in it. It has a protuberant Head (*Fig. IV. (1)*) four Lines broad, next to that a *Crena* or semicircular *Sinus*, (*2*) after which the Bone is rais'd, affording a protuberant Margin to an oblong *Sinus* (*3*) for receiving the head of the *Incus*, four Lines broad. The opposite part of this *Sinus*, or back part of the Bone, is convex of an unequal rugous Surface, with a great many protuberances and depressions, for the Origins and insertions of the Muscles, for the space of five Lines; where it forms an Angle, from whence it becomes Flat and Smooth, being three Lines broad and reaching four

*The Mal-
leolus.*

Line_s

Lines to another Angle, (5.) where the *Manubrium Malleoli* begins, and where it becomes more round; from whence it gradually Tapers to the Point, being six Lines in length.

The head of the *Incus* is four Lines broad, (Fig. VI. (1.) below which is the Neck or an oblique *Sinus*; (2) next to that are two *Spophyses*, one on each side. These descending obliquely outwards, and becoming flat, meet in a Point, (Fig. VII. (5.) whence ascending obliquely inward, this Production is join'd to another small round one, like the *Manubrium Malleoli* $4\frac{1}{2}$ Lines long (6.) This has the fore-mentioned small excavation or half round *Sinus*, (7.) which with the extremity of the *Stapes*, I suppose to have contain'd the *Os quadrangulare*, or rather *Orbiculare*, according to the Figure of the *Sinus*.

The *Stapes* differs much in Figure from the Human one. From its Concave extremity 'tis enlarg'd on each side by two small slender Productions, not unlike the Processes of the *Vertebrae* of some Fishes (Fig. VI. (2. 2) to which is join'd the *Basis*, (3.) so thin almost as the Scale of a Fish. This was accidentally separated from its two Sides, and remain'd in the *Foramen Ovale*, from whence I pull'd it with a Pin; 'Tis Concave towards the *Stapes*, and Convex toward the *Vestibulum*.

The *Foramen Ovale* lyes so hid and obliquely in the side of the *Cavitas Tympani*, that it could not be delineated in its true Dimensions. Near to it is another hole Oblong and Sharp at both ends, both which give an entry into the *Vestibulum*.

The *Vestibulum* is of an irregular Figure, (Fig. X. (a) 'tis for the most part three Lines from the one side to the other, and perforated by eight Orifices, viz. five for the Canals of the *Labyrinth*, (Fig. IX. X. (a)
one

one for the *Cochlea*, (*Fig. X. (b)*) and two for the *Fenestræ (b, c.)*

The *Cochlea* is a long Cavity consisting of three *Gyres* or *Meanders*; (*Fig. XI. (d e f)*) Its Orifice where it proceeds from the *Vestibulum* is but small; but it afterwards widens, so that the first course of this Cavity is a third part larger than the second (*e*), and proportionally the third is less than the other two (*f*), till it terminates in an Orifice (*g*) situated in the Top, for receiving a branch of the soft portion of the *Nervus Auditorius*, which accompanies and passes along all its *Gyres*.

The hardness and solidity of the Bone (for which it may be justly called *Os Petrosum* in this Subject) was such that I could not so exactly trace the three Canals or Ducts of the *Labyrinth*, so as to give a true Idea of the manner of their several Turnings. But *Valsalva's* Figures of the Humane Ear directed me so exactly, that I easily found out the several Orifices, and opened them so far as to find out their situation and true Dimensions, by introducing a Hogs bristle, then cutting it off and stretching it out to the Scale. Thus after laying open the two *Foramina* which gave an inlet to the *Vestibulum*, I soon perceiv'd the several Orifices which in so large a Subject were pretty conspicuous. I first turn'd to the one hand and discovered the *Duct* of the *Cochlea*; this I pursued all along the Protuberance, (*Fig. III. (d)*) in doing of which I laid wholly open the *Lesser Duct* of the *Labyrinth*. (*Fig. IX. X. (d)*) Then turning up the other side of the Bone, I trac'd the soft Portion of the *Nervus Auditorius* divided into two Branches, one whereof was distributed into the *Cochlea*, and the other to the *Labyrinth*. In filing the Bone a little further, I opened a small part of the *Middle Duct*, and in a short time I discovered the *Ductus Major*;

Major; after which I measured their several lengths as is said.

The *Labyrinth* then consists of three *Lineæ Semilunares* or incurvated *Ducts*, whereof the *Major* lyes in that part of the *Processus Petrosus* which regards the seat of the Brain (*b*) This is twenty Lines or one Inch eight Lines long. The *Medius Ductus*, one part whereof regards the Orifice of the *Cochlea*, and the other is common with the *Major* for the space of three Lines; (*e*) this is fifteen Lines or one Inch three Lines long: And the *Minor* which regards the *Cavitas Tympani*, has one Orifice which is near to the *Medius*, were it approaches the *Cochlea*; and the other near to the Orifice of the *Major*. This is one Inch long.

The seventh pair of Nerves called in general the *Nervus Auditorius*, enters the *Processus Petrosus*, and is divided into the hard and soft Portions, as in other Animals. In this Subject I find one Canule entring the Bone from the sides of the Orifice for the *Carotide*

Artery, about three Lines diameter, (*e*) (*b*) from thence running forward for the space of one Inch four Lines, then bending downwards one Inch till it meets with the Orifice at the Sides of the *Meatus Auditorius*, by which it pierces the Skull, and passes outward. This Canule, after it is entred the *Processus Petrosus* for the space of eight Lines, communicates with the Orifice which usually enters the foresaid Process from the Base of the Skull; and both these Orifices, after they have accompany'd one another about five Lines, are separated, and the soft Portion penetrates the Bone at two places, as is said.

I have now endeavoured to give such a Description of the *Osseous* or Bony part of the Ear of this stupendious Animal, as I am in hopes may be useful for the clearing

clearing up of some *Phænomena* in lesser Subjects. At least we may hereby observe, what a variety of Mechanism the great Author of Nature has thought fit to employ, in the several parts of different *Species* of Animals. Thus both the external Ear of Man, and of the *Elephant* lye flat, as being most convenient: for if they had been Protuberant as in most Quadrupeds, how unsuitable would it have been in Man, who is the most perfect of all Creatures, not upon the account of his Reason alone, but also as he is a Pattern for Beauty and the Symmetry of his Parts; and how unseemly would it have been in the *Elephant*, if his external Ear had stuck out, and been proportional to his other Parts; considering what an extraordinary aspect he makes already by his Trunk and Tusks? But the Ears in these two Subjects differ by the tortuosity of the Cartilage, and oblique *Meatus*, to prevent the injury of the Air, by its immediate access into the inner Ear in Man: whereas in the *Elephant* the external Orifice is fully expos'd to the Air; but then the length of the *Meatus* hinders any more Air than is convenient from arriving at the *Tympanum*. We likewise see in the *Seal* and *Otter*, that those two Amphibious Quadrupeds have no external Ear further protuberant than the other Parts of their Head; for had it been otherwise, their swimming and diving would have been much hindred: But its two sides are so collaps'd, that no Water can enter in when in the Deep, though it can receive sufficient Air when ahoar. The cellulous Cavity of the *Tympanum* in the *Elephant*, may well be compar'd to the *Apophyss Mastoides* in Man; and the second Cavity of a plain Surface seems to be Analogous to the Cavous *Mastoides* in *Sheep*, *Cats*, *Dogs*, &c. So that we see that whereas other Animals have but one Cavity for assisting the Vibration of the Air, and continuation of the

Z z z z z z

Sound

Sound in the *Tympanum* ; this Animal has two, or a large one with two different Surfaces. The Aqueduct both by its Figure and Position in this Animal doth plainly shew us the Use of it in other Animals, which is to receive the superfluous Humours in the *Tympanum*, and convey them to be discharg'd in the Mouth.

Explication of the FIGURES.

Figure I.

R Represents the Bony part of the Meatus Auditorius of the Right Ear.

a The external Orifice of the Meatus Auditorius.

b The Processus Petrosus.

c The Orifice where the Nervus Auditorius enters.

d The Meatus Auditorius.

e A part of the Laminæ which proceed from it on each side, by which the Cellules betwixt the two Tables of the Scull are form'd; those situated above the Meatus being remov'd.

f Part of the inner Table of the Scull.

pened, with other parts of the inner Ear.

a The ragged part of the Bone from whence the Os Petrosum was separated.

b The Processus Petrosus opened.

c The Crena for the Membrana Tympani.

d The Honey comb Cavity of the Tympanum.

e Its inner Cavity of a smooth Surface.

f Its Semicircular or undulated Lines.

g The Orifice of the Aqueduct.

h The Orifice of the hard Portion of the Nerve.

Fig. II.

Represents part of the Meatus Auditorius or

Fig. III.

Represents the lower Surface of

of the Os Petrosum, as it was separated from above the Tympanum and other parts of the inner Ear.

a a The ragged Margine of the Bone.

bb The upper part of the Cavitas Tympani.

c The Foramen Ovale.

d The Protuberance in which the Labyrinth and Cochlea are lodg'd.

e The Orifice of the hard portion of the Nervus Auditorius.

Fig. IV.

Represents the Malleolus alone in its true dimensions.

1 The Protuberant Head.

2 The Semicircular Sinus betwixt it and the Margin

3 The Sinus which receives the head of the Incus.

4 The angle below the Sinus for the head of the Incus.

5 The angle where the Manubium Malleoli begins.

6 The Manubrium Malleoli.

Fig. V.

Represents the Incus.

1 The head of the Incus.

2 The Sinus or neck of the Incus.

3 Two Apophyses.

4 A long protuberance with the Sinus for the Os quadrangulare at its extremity.

Fig. VI.

Represents the Stapes.

1 The small part of the Stapes, where it is articulated with the Incus, with a Sinus at its extremity, being the other half of the Cavity for the Os quadrangulare.

2 2 Two small portions of the Stapes, where it is articulated with the Basis.

3 The Basis of the Stapes separated.

4 The whole Stapes.

Fig. VII.

The Malleolus and Incus join'd together, with their lower side turn'd up.

1 The Malleolus.

2 Its articulation with the Incus.

3 The Incus.

4 The Manubrium Malleoli.

5 A point of the Incus, fram'd by the other two Productions.

6 The

- 6 *The long protuberance of the Incus.*
- 7 *The Sinus in the extremity of its long Production.*

Fig. VIII.

The Malleolus, Incus and Stapes articulated together.

- 1 *The Incus.*
- 2 *The Malleolus.*
- 3 *The Stapes where it shuts the Foramen Ovale.*

Fig. IX.

Represents the upper part of the Lineæ Semilunares, or that side which is towards the passage of the Nervus Auditorius.

- a *The five extremities cut off.*
- b *The Linea Semilunaris Major.*
The Semilunaris Media
- d *The Minor.*
- e *The common Canule between the Major and Media.*

Fig. X.

Represents the Cochlea and Labyrinth together.

- a *The Vestibulum.*
- b *The Foramen Ovale.*
- c *The Foramen Oblongum.*
- d *The Linea Semilunaris Minor, which is towards the Cavitas Tympani.*
- e *The common Canule to the Major and Media.*
- f *The Major.*
- g *The Media*
- h *The Cochlea.*

Fig. XI.

Represents the Cochlea.

- a *The Vestibulum.*
- b *The third Gyre or turning.*
- c *The Orifice.*
- d *The first Gyre or turning opened.*
- e *The second turning.*
- g *The Orifice at the top of the Cochlea.*

F I N I S.

ERRATA. N^o. 357. Pag. 847. lin. 22. lege ab b 11'. 32". pag. 885, lin. 27. lege N^o. 326. 327.

L O N D O N :

Printed for W. and J. INNYS, Printers to the Royal Society, at the Princes-Arms at the West-End of St. Pauls Church-Yard. 1719.

Fig. 1,

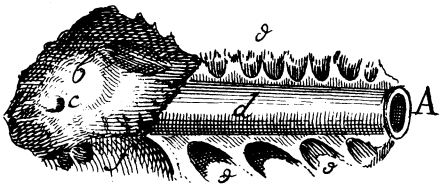


Fig. 11.

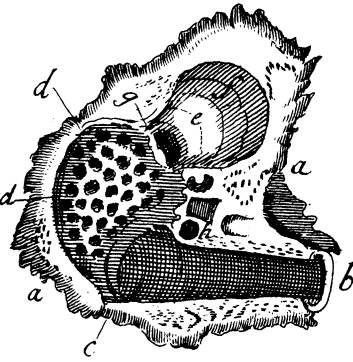


Fig. III

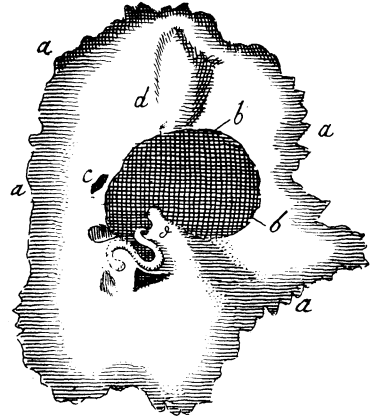


Fig. III



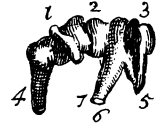
V



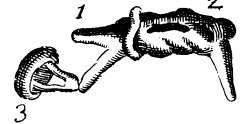
VI



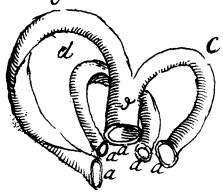
VII.



VIII.



IX.



X

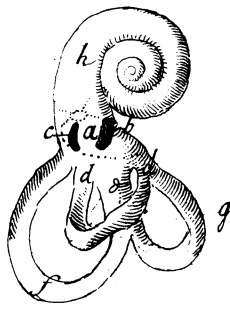


Fig. XI

